STATEMENT OF WORK

SECTION 1.0 – TITLE

1.1 FATIGUE CONTROL SYSTEM

SECTION 2.0 – OBJECTIVE/BACKGROUND

The Structures and Composites Department, Code 65 of the Naval Surface Warfare Center Carderock Division (NSWCCD) operates and maintains several independent universal test machines and servo-hydraulic fatigue test stations that provides the capability to evaluate the structural performance and design concepts of unique, complex ship structures. NSWCCD intends to replace the existing outdated controls of the test systems with new direct digital control electronics interfaced to a personal computer. The control system upgrades will extend the life of the test systems as well as enhance capability and accuracy of structural testing.

SECTION 3.0 - SCOPE OF WORK

The Contractor shall provide a total of six independent PC-based digital servo-control systems. Two of the six systems will retrofit two Baldwin-Southwark universal test machines. The remaining four systems will replace outdated controllers on three uni-axial servo-hydraulic fatigue machines (one Instron and two MTS), and one free-form multi-actuator servo-hydraulic fatigue test station equipped with a single actuator. Each control system must be a "turn-key" system, not a stand-alone, of proven design with state-of-the-art-features as well as provide flexibility to meet various test requirements as specified in the following two separate tasks:

Task One:

3.1 Retrofit two universal test machines.

The Contractor shall retrofit two Baldwin-Southwark basic floor model test machines with rated load capacities of 120,000 pounds and 200,000 pounds. This includes replacement of the existing operator's console and it's functions with a new state-of-the-art PC based digital control system. This new control system and its' application software shall be integrated with the existing load frame to enhance the performance and capabilities as specified in the salient features below. Each control system shall consist of a separate and independent test station containing its' own hydraulic pumping system, computer system and digital controls. Each test station shall be capable of operating in load, stroke and strain control modes.

3.1.1 Retrofit two existing universal test machines to include direct digital servo control interfaced to a personal computer. This includes on-site installation, training and system end-to-end calibration (NIST traceable) including pressure transducer and displacement transducer.

3.1.2 Turnkey PC-based closed loop servo control system with proven design and proof of past performance. System, components and software must already exist.

3.1.3 Hydraulic pumping system including pump/motor combination, air cooled, low oil and high temperature interlocks, safety relief valve, adequately sized reservoir & servo valve, manifold, pressure gage and a minimum of 10 feet of hydraulic hose with appropriate fittings.

3.1.4 Electrical starter and controls to operate sensitive crosshead motor.

3.1.5 Direct digital control (loop closure, offset adjustments, tuning parameters).

3.1.6 Closed loop servo control for load, displacement and strain controlled tests. Each control channel shall have an independent and sperate input channel.

3.1.7 Bumpless (on-the-fly) transfer between all control modes

3.1.8 Force measurement accuracy of +/- 0.5% of reading or better.

3.1.9 Displacement transducer or digital encoder to measure actuator stroke or worktable position. Nonlinearity of 0.05% or better, resolution of 16 bits or better

3.1.10 Pressure transducer with accuracy of 0.1% of full scale range or better

3.1.11 Remote control station (minimum distance of twenty feet from console).

3.1.12 Manual control of load frame to assist operator when installing test specimen.

3.1.13 Microsoft windows platform environment

3.1.14 On-line technical support.

3.1.15 Programmable error and limit detection of all control sensors.

3.1.16 Ability to respond to exceeding a sensor limit by pre-programmed actions

3.1.17 PID control

3.1.18 Manual tuning (via keyboard input not by adjusting discrete components)

3.1.19 Simultaneous real-time graphical & digital display of test data.

3.1.20 Ability to manually adjust offsets, scales and display time of graphical data.

3.1.21 Ability to display cross-plots.

3.1.22 Minimum of one additional full bridge signal conditioning input channel. This shall provide the capability to control the load of a dual-bridge load cell using one of the bridges for load control while monitoring the output of the other bridge.

3.1.23 Ability to accept extensometer inputs from strain channel. Input must be compatible with SATEC model PC4M extensometer and include mating connector and/or adapter cable.

3.1.24 Auto zeroing of control channels

3.1.25 User-definable data acquisition rates up to 500 samples/sec/channel.

3.1.26 Data acquisition: A/D per channel with simultaneous sample-and-hold (i.e. no data time skew)

3.1.27 Buffered signal outputs for load, stroke, feedback and command.

3.1.28 Data compatible with MS Excel.

3.1.29 All digital signal processing must be 16-bits or better.

3.1.30 Personal Computer (Minimum Configuration)

MS Windows Operating System

Pentium 4 Processor @ 2.0 GHz

256 MB SDRAM Memory

30 GB Hard Drive

CD-ROM X48

3.5 Floppy Drive

Graphics Accelerator

10/100 Network Interface Card with RJ-45 Connection

104+ keyboard

MS mouse

17-inch color monitor

Mini-tower

3.1.31 Color Printer

3.1.32 Operator's Control Console

3.1.33 Application software to manage and automate the testing process from entering predefined test parameters to conducting a test and acquiring data.

3.1.34 Software utilities must be provided to create and edit specific test configurations for command generation, test sequence, control procedures, data acquisition, on-line monitoring, sensor calibration files and digital data storage. Test wizards or a series of window utilities utilizing features, such as, pull down menus, drag-and-drop, file edit, text-sensitive help and toolbars shall be used to minimize the time required to set-up and run tests.

3.1.35 Tensile and compression test applications (Note: System can not combine both tension and compression loads due to structural design).

3.1.36 Monotonic waveform generation and control.

3.1.37 Ability to configure test procedures to switch modes of control; change speed; generate load, displacement and strain rate loading; generate ramp and hold sequences; pause, hold or stop a test, etc.

3.1.38 To ensure test repeatability, all software parameters associated with a test such as test configuration, limit values and actions, data acquisition setup and loop control values shall be saved with user identifiable names and capable of being recalled so an exact reproduction of the test can be performed.

Task Two:

3.2 Fatigue Machine Controller Upgrades

The Contractor shall provide turn-key control electronics and software that separately and independently control four test stations: three uni-axial load machines, and a multi-channel system that will control one actuator, but that can be configured at a future date to control up to four actuators on the same test or four separate tests for the free-form test station.

The new control systems are to control each test station independently from the others with each actuator controlled in either load (DC) or stroke (AC/LVDT), and upgradeable to include strain (DC). Each test station controller must have selectable load and stroke ranges with bumpless control mode switching. The control system is to consist of three independent single-station control systems, one for each of the three uni-axial test stations and a fourth, multi-station control system that will control one actuator, but be expandable to control four actuators for the free-form test station at a future date. The control systems must be capable of generating a continuous command signal for static ramp loadings, constant and random amplitude fatigue loadings defined by peak and trough endpoints, arbitrary block loadings, or follow a command signal input from an external source.

3.2.1 Digital Control Electronics compatible with existing hydraulic power supplies, service manifolds and solenoids.

3.2.2 Microsoft windows platform environment

3.2.3 Closed-loop separate and independent control of the four test stations as described in Section 4.2: three servo-hydraulic uni-axial test stations, and a multi-channel test station with one existing actuator, which can be expanded at a future date to accommodate a total of four actuators independently or simultaneously.

3.2.4 Control modes of both load and stroke, upgradeable to include strain control

3.2.5 Bumpless and on-the-fly (event) switching between any control modes

3.2.6 Monotonic and cyclic command waveform generation and control

3.2.7 Support constant, variable, block fatigue tests, cyclic waveform fatigue tests defined by at least 100,000 endpoints, cyclic fatigue tests with and without mean level, in addition to static and ramp loadings

3.2.8 Command signal and gain adaptive compensation to achieve desired feedback, with programmable error and limit detection

3.2.9 Control of hydraulic power supply, service manifolds and associated interlocks

3.2.10 Local control pad at each test station to aid in specimen installation

3.2.11 Control two and three stage servo-values as appropriate

3.2.12 Data acquisition with at least 16 bit conversion, limit and error detection, user defined data acquisition rates up to at least 200 samples/second/channel, A/D per channel with simultaneous sample-and-hold (i.e. no data time skew), and ability to accept and condition at least two external transducers in addition to load and actuator stroke per test station

3.2.13 Buffered signal output jacks for load, stroke and strain feedback and command for each test station

3.2.14 Real time data acquisition displays and data compatibility with Microsoft Excel; data to be acquired in various formats such as peak/valley, min/max, timed data, and level crossing

3.2.15 Automatic and manual tuning to optimize control loop parameters

3.2.16 Simultaneous real-time graphical and digital display of test data in standard and/or metric units

3.2.17 Initial setup, installation and system end-to-end calibration of control system and test equipment included up to stated capacities with the following exception: the 1 million lb capacity frame is only to be calibrated to 500 kips

3.2.18 Separate monitoring stations for each test

3.2.19 Available on-line technical support

3.2.20 Available follow-on field service, repair and calibration services

3.2.21 Versatile software configuration, expandable to independently control uni-axial actuators or a multi-actuator free-form test station with up to four actuators, hydraulic power supply and hydraulic service manifold, using additional or different hardware

3.2.22 System, components and software must already exist; product literature required

3.2.23 Personal Computer (Minimum Configuration)

MS Windows Operating System

Pentium 4 Processor @ 2.0 GHz

Integrated DVMT Video

256 MB DDR SDRAM Memory

30 GB EIDE Hard Drive

CD-ROM 20X min./48X max.

3.5 Floppy Drive 1.44MB

Integrated Intel 10/100/1000 Network Interface Card

Slots: 3 full length PCI and one AGP

104+ keyboard

MS mouse

17-inch color monitor

Mini-tower

SECTION 4.0 GOVERNMENT FURNISHED INFORMATION (GFI)

4.1 Universal Test Machine Retrofit:

The 120 kips test machine, serial number 36100, has a 9.5-inch diameter piston with an 10-inch power stroke and the 200 kips test machine, serial 42260, has a 13-inch diameter piston with a 12-inch power stroke. Each test machine is comprised of an independent hydraulic load frame and an operator's control console. These machines are capable of subjecting test specimens to tensile or compressive loads up to the maximum capacity of the machine but cannot combine both tension and compression loads due to the structural design. These are static test machines and currently operate only in load control. Indexed micrometer valves are used to manually control the applied load.

The load frame assembly utilizes a single acting, gravity return type hydraulic cylinder. Attached to the piston is the worktable, which carries two compression columns and the top (tension) crosshead. Between the top crosshead and the worktable is the sensitive crosshead. Movement of the piston is always in the upward direction and imparts an upward force on the sensitive crosshead. The applied specimen load is measured by means of a Tate-Emery hydraulic weighing capsule located between the hydraulic cylinder and the base of the frame. The output of the weighing capsule is connected to Bourdon tubes of the load indicator. Both test machines have the same principle of operation and differ only by their physical size and load & stroke capacity.

The operator's control console is comprised of a hydraulic pump assembly, a load indicating system, control valves and a stress-strain recorder. It is the intent of this procurement to replace the operator's console and its' functions with a new state-of-the-art PC-based digital control system.

4.2 The existing Fatigue Machine Controller, associated with this procurement, is comprised in an arrangement of independent test stations: three separate uni-axial load frames and a free-form test fixture. Each test station has its own hydraulic power supply, hydraulic service manifold, and servo-control electronics to conduct static and cyclic fatigue testing. The free-form test station has a service manifold ported to independently support up to four separate hydraulic actuators from a single hydraulic power supply, although it currently supports only one actuator. Each test station is operated independently from the others through its own hydraulic power supply, service manifold, load (DC)/stroke (AC/LVDT)/strain (DC) feedback, servo valve controllers, and AC solenoids. Although each system also contains a function generator, a computer and external electronics are used to generate a continuous command signal for constant and random amplitude fatigue loadings defined by peak and trough endpoints.

The load capacities of each test station are ±20 kips (free-form MTS equipment: model 293.11B-04 service manifold, model 244.22S actuator, model 760C563A (Moog)

servo-valve, model 661.20E-03 load cell, model 501.01 hydraulic power supply), ±100 kips (MTS equipment: model 290.11 service manifold, model 301.03 load frame, model 252.760C263A servo-valve, model 510.10C hydraulic power supply), ±200 kips (Instron equipment: model Z4035 service manifold, model CW2105 load frame, model 72-101 (Moog) servo-valve, model 210-20 hydraulic power supply), ±1000 kips (MTS equipment: series 284 service manifold, model 903.52 load frame, model 253.31 servo-valve, Airline Hydraulic Corp. (Job A-3497) hydraulic power supply). The largest capacity test station uses a three-stage servo valve; the others use two-stage servo valves. Each test station also has an LVDT to measure actuator movement. All uni-axial test stations have selectable load and stroke ranges with bumpless control mode switching.

SECTION 5.0 - GOVERNMENT FURNISHED EQUIPMENT (GFE)

5.1 The Contractor shall be required to install the specified control systems at the NAVAL SURFACE WARFARE CENTER, CARDEROCK DIVISION located in Bethesda, Md.

5.2 The retrofit of the two universal test machines will be performed in the Structural Evaluation Laboratory, Building 19, C-Bay. The Government shall be responsible for the disassembly and removal of the existing operator's control consoles in preparation for the installation of the new control systems and provide suitable AC operating power within fifteen feet of each load frame.

5.3 The installation of the Fatigue Machine Controller Upgrades will be performed in the Fatigue and Grillage Test Facility, Building 19, B-Bay. The location for the control electronics will reside in a room of wire path length no longer than 75 feet away from the test stations and 100 ft from the hydraulic power supplies.

SECTION 6.0 - PERFORMANCE AND DELIVERY

6.1 The Contractor shall complete all tasks under this contract by 31 December 2003. Each control system upgrade/retrofit shall be furnished complete and ready for use.

6.2 Provide hard copy of user's manuals and documentation for each control system. The contractor shall furnish manuals which provide a detailed description of the overall system, the operation of the Control System hardware and software as well as diagrams for the overall assembly and interconnections. Additionally, manuals for the host personal computer and all peripheral equipment must be provided.

6.3 Control System calibration certificates and verification reports must be provided. This includes calibrations for force and displacement measurements.

6.4 The Retrofit/Upgrade shall be warranted from defects in material and workmanship for a period of one year from the date of delivery. Any Control System software revisions must also be provided during this period. Should trouble develop anywhere within the

Control System during the warranty period, the contractor shall furnish all labor, parts, and equipment necessary to restore normal operation as quickly as possible.

SECTION 7.0 - CONFERENCES AND MEETINGS

On-site training shall be provided for each of the six control systems. Training shall consist of local and remote operation of the control system, test generation, data acquisition & display and actual conduct of a test.

SECTION 8.0 - TRAVEL

8.1 Travel required by Contractor from origin of business to NSWCCD at Bethesda, Md for purpose of installation and training of control systems.

SECTION 9.0 - SECURITY REQUIREMENTS

9.1 All work performed on this contract will not exceed the level of UNCLASSIFIED.

SECTION 10.0 - TECHNICAL POINT OF CONTACT

10.1 Retrofit of Universal Test Machines:

Mike Jenkins, email: jenkinsrg@nswccd.navy.mil
(301) 227-2695, Fax (301) 227-2944

10.2 Fatigue Machine Controller Upgrades:

Dr. David Kihl, email: kihldp@nswccd.navy.mil
(301) 227-1956, Fax (301) 227-1020

SECTION 11.0 - SUBMISSIONS

11.1 The proposal will be evaluated based on low cost and being technically acceptable

11.2 All proposals must include an itemized list of equipment to be supplied, including product literature describing its specifications, operation and its relation to the overall upgrade/retrofit.

11.3 Contractor ***must explicitly*** address each of the salient features listed in Section 3, Scope Of Work. Failure to demonstrate full compliance will be deemed as technically unacceptable.

11.4 Provide list of at least three similar test machine retrofit installations(elsewhere) including points of contact.

11.5 List of items/equipment that may be supplied by customer separately and discounted from final price; for example computer